

Study of Architecture and Construction Materials of Ancient Havelis

A Major Project Report

Submitted to the Rajasthan Technical University

in partial fulfillment of requirements for the award of degree

Bachelor of Technology

in

Civil Engineering

by

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CERTIFICATE

This is to certify that the report entitled **Study of Architecture and Construction Materials of Ancient Havelis** submitted by **Kamal Singh Rao** (University Roll No.: 20ETCCE004), to Department of civil Engineering in partial fulfillment of the B.Tech. degree in **Civil Engineering** is a bonafide record of the seminar work carried out by him under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

I Kamal Singh Rao hereby declare that the major project report, **Study of Architecture and Construction Materials of Ancient Havelis** submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the Rajasthan Technical University, Kota, Rajasthan is a bonafide work done by me under supervision of Mr. Nishit Jain.

This submission represents my ideas in my own words and where ideas or words of others have been included, I have adequately and accurately cited and referenced the original sources.

I also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. I understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma, or similar title of any other University.

10/05/2024


Kamal Singh Rao

Abstract

Winston Churchill right away says the grasp of architecture & surroundings with the phrase that “We shape our buildings & later they shape us. Architecture is a civic profession that feels all human beings at all levels of their reality everywhere & every day. The space induced a previous old historical descendant to suggest that spaces grip our mind to think about the past events & incidents in it. The world should move towards sustainability through the vernacular aspects. In this Rapid growing modern world, the built form is majorly mechanized with the active technologies which in turn increases the cost of living. Vernacular principles provide a comfortable living environment through sustainable principles & energy-efficient techniques. Indigenous architecture is the only solution to the problem the world is facing. This project's result represents, what does haveli mean? Through spaces & function in architecture. we also form the valid highlighting points with supporting case study. We found valid passive design ideas, intrinsic construction details of Havelis of Rajasthan. Also, endorse the vernacular aspects in the modern building through Indigenous architecture of Haveli & its responsiveness to location & climate through the case study of *Haveli at Jodhpur* which promotes more sustainability with high energy-efficient techniques.

Acknowledgement

I take this opportunity to express my deepest sense of gratitude and sincere thanks to everyone who helped me to complete this work successfully. I express my sincere thanks to **Mr. Rakesh Yadav**, Coordinate of Department, Civil Engineering, Techno India NJR Institute of Technology Udaipur for providing me with all the necessary facilities and support.

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Contents	
Abstract	i
Acknowledgement	ii
Contents	iii
List of Figures	v
1 Chapter 1	
1.1 Introduction	1
1.1.1 Brief Overview of Havelis in Rajasthan	1
1.1.2 Importance of Studying Ancient Havelis	2
2 Chapter 2	
2.1 Methodology	3
3 Chapter 3	
3.1 Detailed Information About Havelis	4
3.1.1 History of Havelis	4
3.1.2 Factors	4
3.2 DETAILED FEATURES of HAVELIS	5
3.2.1 Chhatris:	5
3.2.2 Jallis	6
3.2.3 Jarokhas	6
3.2.4 Chajjas	9
4 Chapter 4	
4.1 Case Study	10
4.1.1 Site Selection	11
4.1.2 Basic structure of haveli	11

4.1.3 Doors and walls	14
4.1.4 Windows and Jallis:	15
4.1.5 Roof of haveli.	16
4.1.5.1 Construction of Roof of haveli	17
5 Chapter 5	19
5.1 Conclusion.	19
5.1.1 Indigenous Design Solution in Modern Buildings	19
6 Chapter 6	21
6.1 Literature review	21
6.1.1 Article 1	21
6.1.2 Article 2.	21
6.1.3 Article 3	22
6.2 Reference	23

List of Figures

1.1 Magnificent Havelis of Rajasthan	1
2.1 Detailed stages of framework.....	3
3.1 Chhatris.....	5
3.2 Jallis of the Haveli.....	7
3.3 Jarokhas.....	7
3.4. Chajjas.....	9
4.1. Location of Haveli.....	10
4.2 Entrance of Haveli.....	11
4.3 Map of Haveli.....	13
4.4 door of Haveli.....	14
4.5 wall of Haveli.....	14
4.6 Widows of the Haveli.....	15
4.7 Jallis of the Haveli.....	15
4.8 Roof of Haveli.....	16
4.9 Construction of Roof of Haveli.....	17

CHAPTER – 1

Introduction

The enchanting state of Rajasthan, known for its vibrant culture, majestic forts, and opulent palaces, is also home to a treasure trove of architectural marvels known as Havelis. These magnificent structures, adorned with intricate carvings, vibrant frescoes, and ornate Jharokhas, stand as testaments to the rich cultural heritage and opulent lifestyle of bygone eras. Among the various cities in Rajasthan a remarkable collection of ancient Havelis that offer a glimpse into the region's architectural splendor and historical legacy.



Alsisar Haveli - Jaipur



Nathmalji ki Haveli - Jaisalmer



Mandawa Haveli - Shekhavati



Bagore Ki Haveli - Udaipur

Fig. 1.1 Magnificent Havelis of Rajasthan

Brief Overview of Havelis in Rajasthan

Havelis, meaning mansions or large residences, are traditional Indian townhouses or palatial homes typically found in the northern regions of India, particularly in the desert state of Rajasthan. These architectural gems are characterized by their grandeur, intricate

craftsmanship, and unique blend of indigenous and foreign influences. Rajasthan, with its arid landscape and princely history, emerged as a crucible of Haveli architecture, where skilled artisans and craftsmen unleashed their creativity to construct resplendent edifices that mirrored the opulence and prestige of the Rajput rulers and affluent merchant families.

The architectural style of Havelis is a testament to the fusion of Rajput, Mughal, and European influences, resulting in a distinctive aesthetic that is both majestic and elegant. Elaborate facades adorned with finely carved sandstone panels, graceful arches, and latticed screens known as jalis, are characteristic features of Haveli architecture. Moreover, the interior spaces of Havelis are adorned with intricate frescoes depicting mythological themes, floral motifs, and scenes from everyday life, showcasing the artistic prowess of the craftsmen who painstakingly adorned these palatial residences.

Importance of Studying Ancient Havelis

Today, the building zone causes up to 30-40% of the world's whole energy consumption (I.E.A-2008). In developing countries (World Energy Outlook 2007) it takes for a lot over percentage. A big part of energy utilized in buildings is used to earn thermal comfort for the resider/inmate through cooling, heating & lighting. Vernacular architecture connects a universal way to draft the buildings so that many contradictory problems & demands of ecology, economy & Human wellbeing are combined. Current buildings are more inept to fit a warming climate & are naturally energy fast/deep into it. In adverse vernacular architecture also flexible to environment allow to ethic/value by varied generation.

The study of ancient Havelis holds immense significance from historical, architectural, cultural, and sociological perspectives. Firstly, Havelis serve as tangible repositories of history, offering insights into the socio-economic dynamics, cultural mores, and architectural techniques prevalent during the bygone eras. By delving into the architectural features, construction materials, and spatial organization of Havelis, scholars and historians can unravel the intricate tapestry of Rajasthan's past and gain a deeper understanding of its cultural heritage.

Furthermore, the preservation and documentation of ancient Havelis are imperative for safeguarding our architectural legacy and fostering a sense of cultural identity and pride. In an era marked by rapid urbanization and modernization, many Havelis are facing the threat of neglect, decay, or indiscriminate redevelopment. Therefore, studying ancient

Havelis not only aids in their conservation but also raises awareness about the need to protect these architectural marvels for future generations.

Moreover, ancient Havelis are not merely relics of the past; they continue to exert a profound influence on the socio-cultural fabric of Rajasthan. These architectural wonders serve as living repositories of traditional craftsmanship, architectural techniques, and indigenous knowledge systems, which are invaluable resources for contemporary architects, designers, and urban planners seeking to revive traditional building practices and promote sustainable development.

2. METHODOLOGY

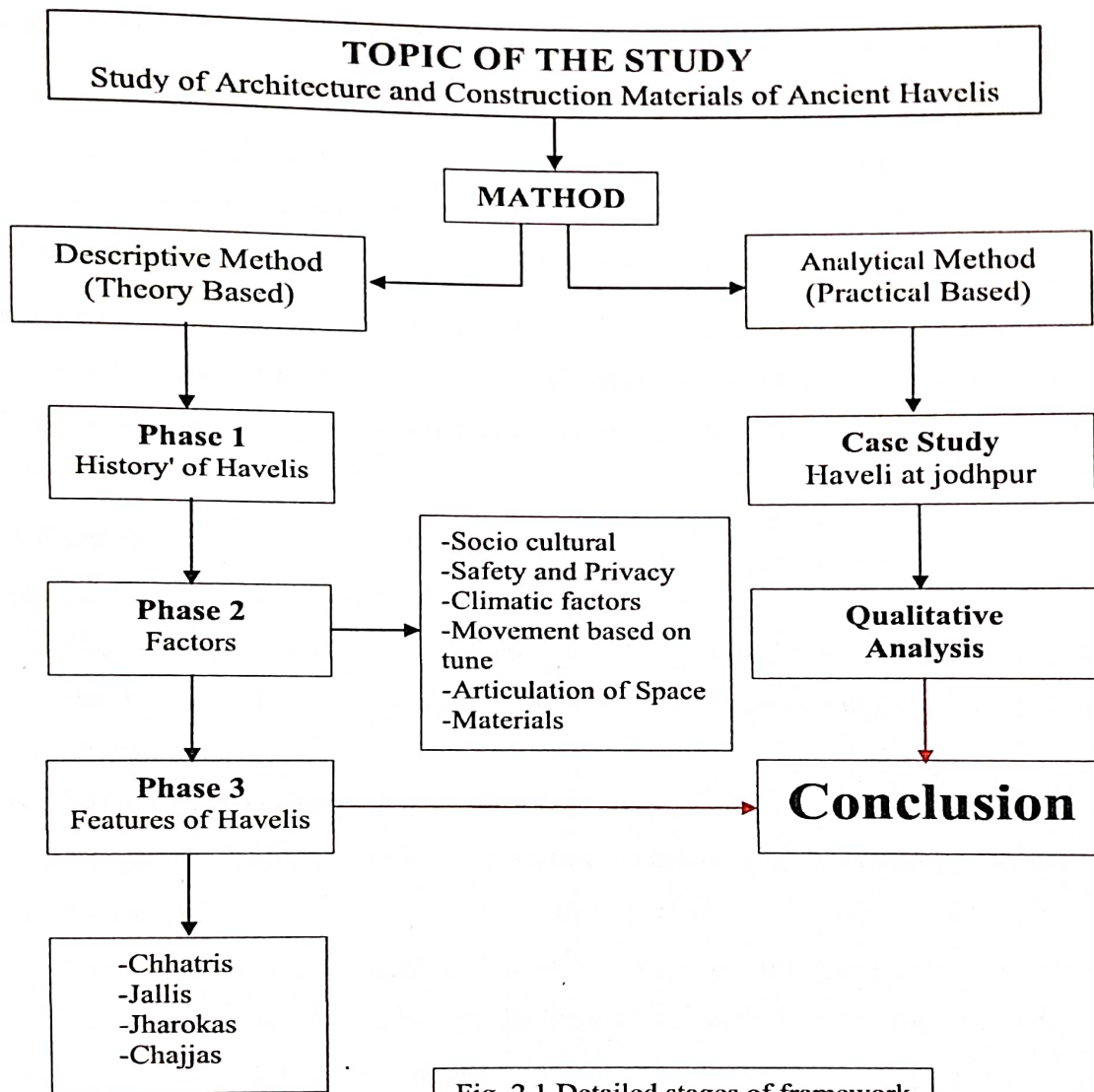


Fig. 2.1 Detailed stages of framework

CHAPTER 3

3.1 DETAILED INFORMATION ABOUT HAVELIS

3.1.1 History of Havelis

HAVELI - Mansion, Residence, Dwelling, Estate, Habitation, Manor, Villa.,Etc.

- The term Haveli arises from Arabic, Ancient havelis dressed Muslim emperor of Indian Subcontinent & evolve into an essential architectural part of urban environments below the Mughals. Although havelis rise from Indo-Islamic architecture the life of multistory homes in area is claimed as early as 3300 BCE.
- The rise of Havelis in urban environments can be attributed to the flourishing trade routes and urbanization during ancient times. As trade routes expanded, urban centers became hubs of economic activity, attracting wealthy merchants and traders who commissioned the construction of elaborate Havelis as symbols of their prosperity and social standing.
- It has exact contrasting architectural approach from traditional havelis that exist refined below Muslim rule. Conventional havelis in Indian Subcontinent are made over a courtyard, and all family action revolves around this chowk or courtyard. Also, the courtyard aids as a light wells & serve ventilate the house in hot & dry climates of region.
- While the medieval period, the name haveli was also utilized in Rajputana by the Vaishnava to mention to their holy place in Gujarat covered by the Mughal Empire & Rajputana kingdoms. The ancestral caption haveli finally near to be labeled by townhouses & Mansions of merchant class.

3.1.2 Factors

- **Sociocultural condition:**

The Chowk or courtyard provided as the Centre for differing ceremonies & customs -The Holy Tulsi plant is situated here & glorified daily to help growth to house

- **Safety & privacy:**

The chowk, at span, divided spaces for men & women keep them by privacy.

- **Climate:**

Utilizing open area in building form to react to regional climate, air flow induced by temperature changes comfort in the Natural ventilation of the dwelling unit.

- **Movement based on time:**

In morning, the courtyard was utilized regularly by women to perform their work

& communicate with more women in private open space. -Palace of the Vendor caste usually had over than one courtyard.

- **Articulation of space:**

Chowk, piece of the city mansion group in Udaipur, there is the theory of the courtyard as a Dancing room. Likewise, in havelis a courtyard has many functions, generally used for weddings & festive shows.

- **Materials:**

Bricks, sandstone, marble, wood, plaster, granite are frequently used materials.

Decorative looks are determined by various local skills & heritage.

All those factors tie to build a place & contribute the chowk collected assure feel. The shape of havelis has expand in reaction to climate, lifestyle & availability of material. In hot climates where cooling is essential buildings with internal courtyards for breeze & cooling were express the utmost suitable fitting of form. In rainy site the houses were made to be stored.

3.2 DETAILED FEATURES of HAVELIS

3.2.1 Chhatris:



Basic Structure of Chhatris



Chhatris of Haveli at Ramgarh

Fig. 3.1 Chhatris

Grant arch form canopy used & a detail in IndoIslamic architecture & Indian architecture. Beginning as a shade over tombs; it reacts a enhancing element. The enhancing case of chhatris existence utilize in Indian Subcontinent exist fix in Mausoleum of Ibrahim in Bhradeswar. -Still used in Rajasthan & More unit of Indian Sub-continent by the pair Muslim & Hindu emperor its roots are IndoIslamic.

About it:

One of the rich of all Memorials, the Chhatri nonce perfectly crafted cenotaphs expose it as a great visitor interest in it. The Commemorative badge is made in the mind of Sage Vyas who had recorded the tale Mahabharata is a ritual Pyre land for the Brahmins placed in Jaisalmer. - The Shrine devoted to the sage is placed north of the whole structure. These shrines were built as a motif of tribute to the crew of the regal group later it's dying. The glory & goods of chhatris & pillars show the Evergreen Rajasthani architecture. Intrinsic layout, figures & the material used must have been elite. The chhatri is still widely noted as the Sun- set mark ceding a exclusive view of the beautiful city of Jaisalmer. Expressing back the form the tricky slash of arcades structures are numb in their debut. A Stay here will give you an enduring peace & calm in particularly mid dusk. Its able hint of the stout life who trek on this tar & is a glad hint of India's Civilization & Haves craft life who trek on this tar & is a glad hint of India's Civilization & Haves craft. The Obelisk order was made for the fond regard of Rajput emperor & its families from the civic patch sandstone. The area's usual Bhatri Rajput king made these tomb to respect the grant of their precursor. The Mild cleft on these. Chhatris are the top case of real latent of Rajasthan buildings.

3.2.2 Jallis:

- A Jali or Jaali is a meaning "Net". The style for a permeate stone or net screen mostly with a decorative mold build over the avail of Calligraphy, Geometry or Natural patterns. This style of architectural frill is typical in Indo-Islamic architecture & also usually in Islamic architecture. It admit light & air while underrate the sun & rain.
- Also, when the air cross over these openings, its velocity rise offering deep scattering. The Gap are much about the equal width or less than the density of the stone, thus given structural stability. It has been descried that moist space like Kerala & Konkan have best dent with total fort quantity than correlated with the dry climate regions of Gujarat & Rajasthan. With the extensive use of glass in the

move recent 19th century, Density of the residential space in Contemporary India, Jallis develop into less usually for Secrecy & Armor thing.

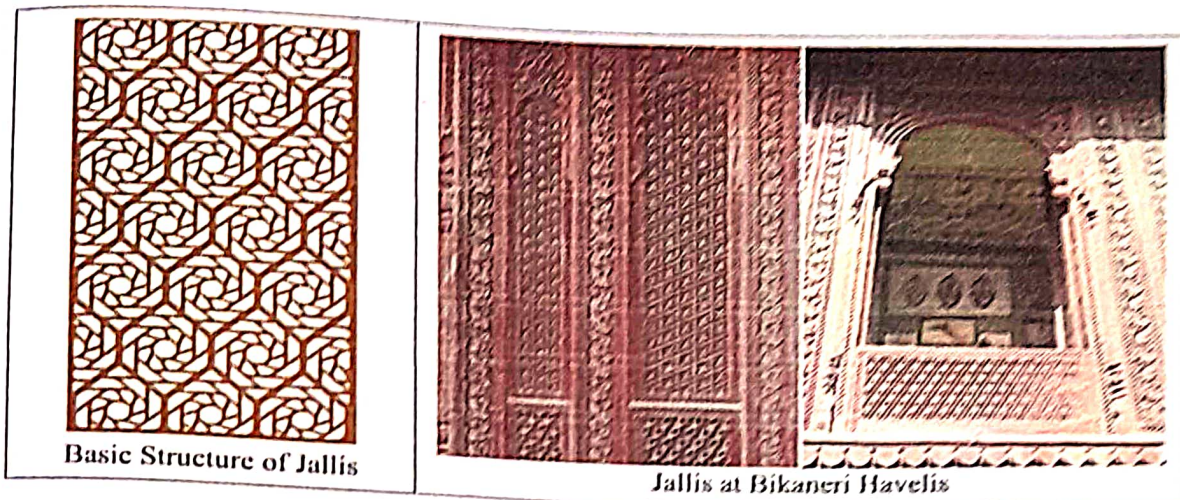


Fig.3.2 Jallis of the Haveli

3.2.3 Jharokhas:

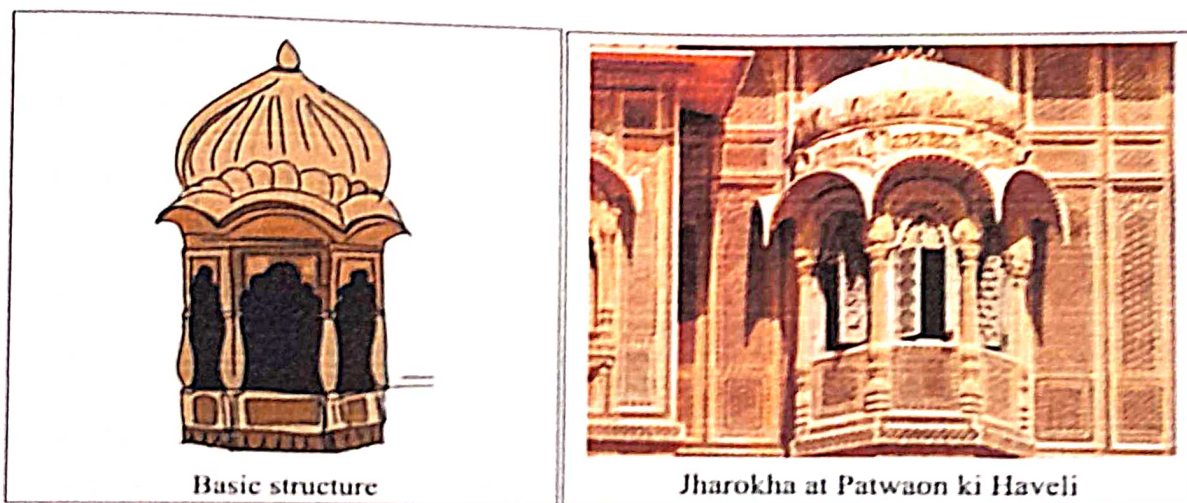


Fig.3.3 Jarokhas

Shape of extend cover porch about verified in temples, havelis & palaces fixed in Rajasthan. The Jharokha balcony I primarily stone window. It active for Spare structural style to the building for any more definite limits. While prior days, women with shawl use to see outermost by concealing themselves internal this attire.

- The Project balcony is a key form of Rajasthani architecture make it need as tool

embellishment & too as a vision noticing platform. There are lot of Jharokhas fetch chhajjas with them. It worn to start back separating the façade face. It keep be used the pair to raise the aesthetics of the building alone for a limited design. One of the best corping part that could be erect in past, the casement keep add secrecy that admit women to notice the fact in exterior left out the presence seen by others in mansion these Jalousie could also be worn to area curves & scout.

Jharokha is utilizing to

- Aesthetic representation
- Climate condition
- Elevation treatment

Not purely an aesthetic aspect; in fact, it also help the act of secrecy & had a thermic gain by one more set of windows. The previous structure of the home were worn to afford typical heating & cooling by cross-ventilation. The Jaalis & Jharokhas are not onliest for secrecy & ornamental idea still more for purifying & freshning. Feat as atmospheric mitigator admit ventilation & tie direct sun into the interior.

Characteristics:

- Project from the wall
- Does not stretch to ground
- Promoted by brackets or carbels regularly truly ornate, symbolic & ornamental in medieval times.
- Normally on upper floors

Sense for utilize Jharokha appear to be climatic as it covers the network from direct sunlight & admit air to crawl the main space. This Window used in hot & dry climate belt. The Façade clear to sun reduce repeatedly applying this detail. The Exterior look of construction worn to be a coat with this kind of protruding extend hang, jaali & small vent in it works for ventilation purpose. Passive system used to control thermal relieve. More a feasible architectural part like Jalis (Screens), Verandas, Fountain, Plants, Chajjas, Courtyard, Basements that admit ventilation but obviated Direct glare.

3.2.4 Chajjas:

A chajja is a projecting or overhanging eave or sunshade that is typically constructed over windows or doors in a building.

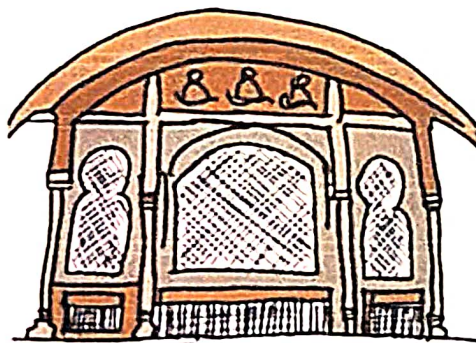
- Functions:

- Provides protection from direct sunlight, rain, and other weather elements.
- Helps in shading the building, reducing solar heat gain, and lowering the cooling load.
- Enhances the aesthetics of the building's facade.
- Prevents water from entering through windows during rainy weather.
- Offers a decorative element to the building's exterior.

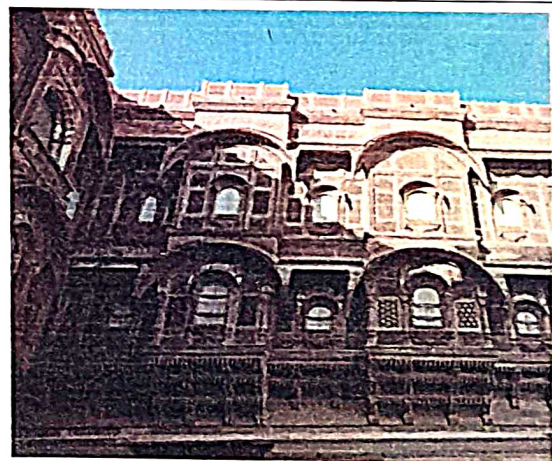
It is an extend Soffit or Ceiling cover in Indian architecture. It is typify with huge hold support with distant artistic model or pattern. Mutation is also note in area built upon the concern of building on which it faces or best of designer. Its part is same to that of other project or soffit in that it save & decorate entrances, arches & windows from external part. Some tone of dome can be examined large chhajja a whole.

Even there is no clear accord on when the chajjas develop as an architectural part, it can be imitated end to ere the growth of Mughal realm in India.

The type of idea of the Chhajja's a lot of the new Indian Architectural drop with it regularly outlined end to building design from older years.



Basic Structure of Chajjas



Chajjas of Haveli At Mehrangarh Fort

Fig. 3.4. Chajjas

4. CHAPTER 4

4.1 CASE STUDY

Region: Jodhpur, Rajasthan

Climatic condition: Hot & dry climate

Temperature: Max 49.2deg Celsius, Min 1 deg Celsius

Rainfall: 16.4 cm

Design Strategy: Resist heat gain, Promote heat loss

Location:

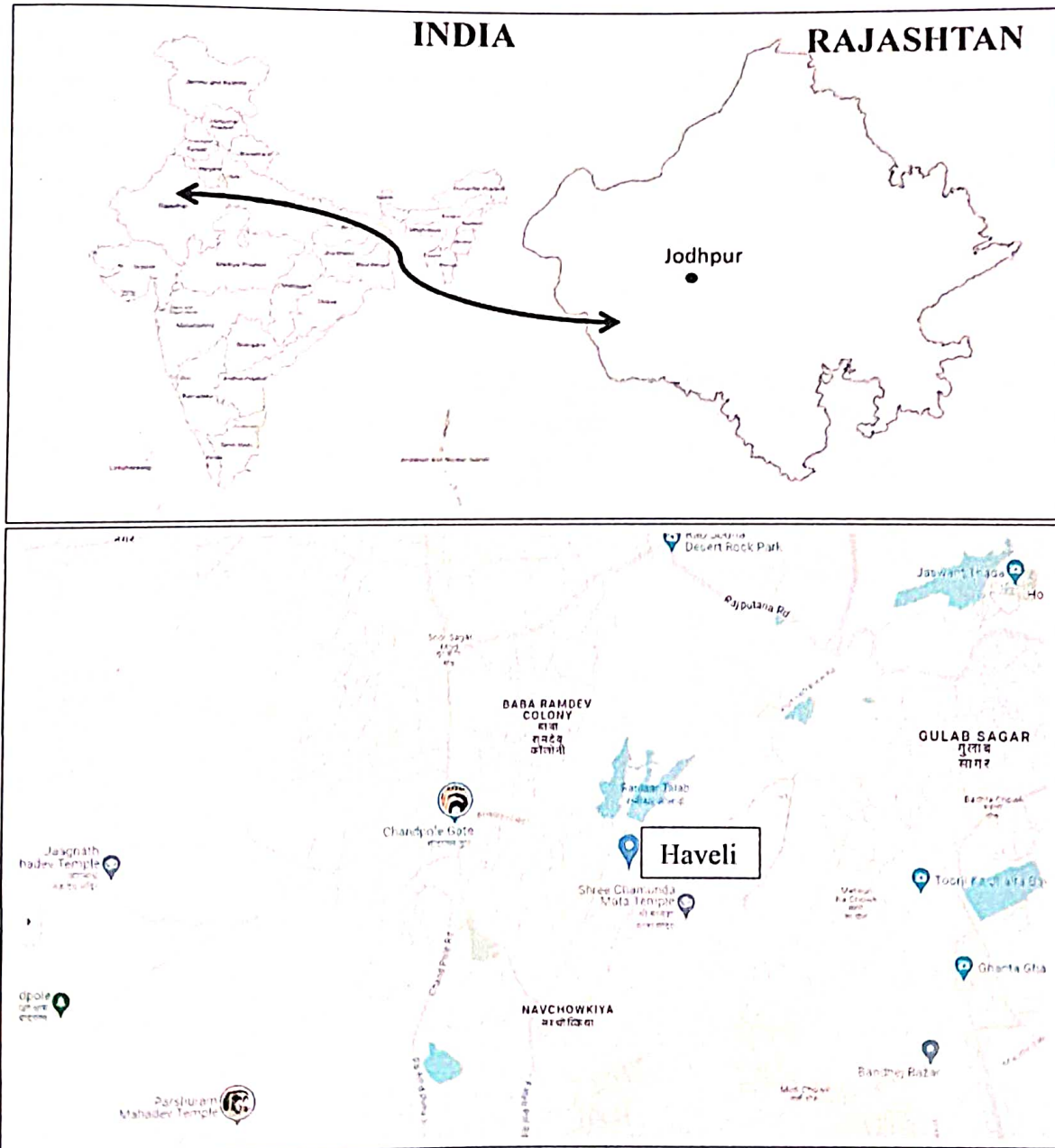


Fig.4.1. Location of Haveli

4.1.1 Site Selection:

There are countless Havelis scattered across the majestic landscape of Rajasthan, each bearing witness to centuries of history and architectural splendor. However, amidst this rich tapestry of heritage, I was drawn to a particular Haveli in Jodhpur undergoing renovation. The decision to focus on this specific Haveli stemmed from a desire to delve deeper into its architectural features and construction materials. The ongoing renovation presented a unique opportunity to examine the Haveli up close, allowing for a meticulous study of its intricate details and craftsmanship. By witnessing the restoration efforts firsthand, I aimed to gain insights into the traditional building techniques and conservation practices employed in preserving Rajasthan's architectural heritage. Moreover, studying a Haveli in the midst of renovation offered a glimpse into its structural integrity, conservation needs, and historical significance, enriching my understanding of its cultural heritage and enduring legacy. Thus, amidst the myriad Havelis of Rajasthan, this one stood out as a beacon of exploration and discovery, beckoning me to unravel its secrets and celebrate its timeless beauty.

4.1.2 Basic structure of haveli:

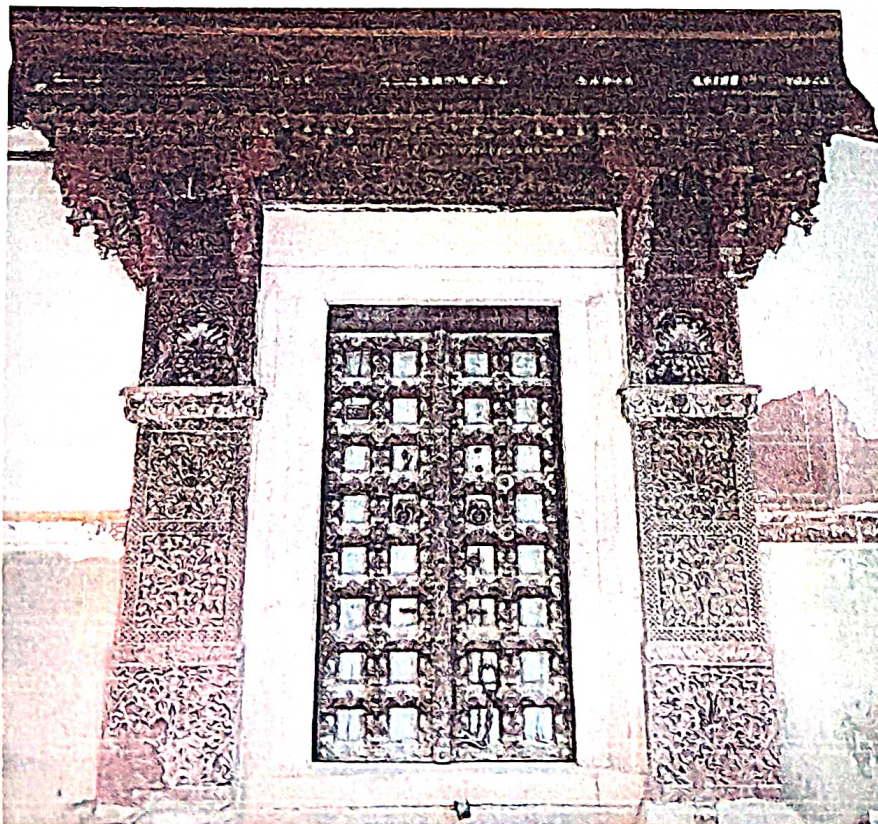


Fig.4.2 Entrance of Haveli

With an expansive area of approximately 4000 square feet, this Haveli stands as a testament to grandeur and architectural excellence. Welcoming visitors with a magnificent entrance, it commands attention with its imposing facade and intricate detailing. Positioned to the north, the Haveli enjoys the auspicious orientation believed to bring prosperity and positive energy.

Upon entering, one is greeted by the grandeur of open spaces, known as 'Chowk', strategically located within the compound for large gatherings and community events. These open courtyards serve as focal points, offering ample space for social interactions, festivities, and cultural celebrations.

As a two-story building, the Haveli embodies a sense of verticality and elegance, with each floor meticulously designed to maximize space and functionality. Throughout the interior, columns stand tall and proud, spaced approximately every 10-15 feet apart. These columns, each a masterpiece of craftsmanship, are hand-carved from a single large stone, showcasing intricate motifs and designs that reflect the artistic heritage of Rajasthan.

Connecting these majestic columns are handcrafted arches, known as 'mehraab', which add an element of grace and symmetry to the architectural composition. These arches, with their graceful curves and ornate carvings, create a sense of continuity and flow, guiding the eye upwards and accentuating the verticality of the space.

Beyond the living quarters, the Haveli features a network of open spaces, corridors, and passageways that connect different parts of the compound. These architectural elements not only facilitate movement within the Haveli but also create visual interest and depth, enriching the overall spatial experience.

In essence, this Haveli is not merely a structure but a testament to the ingenuity, craftsmanship, and cultural richness of Rajasthan. With its magnificent entrance, north-facing orientation, spacious courtyards, and meticulously crafted columns and arches, it stands as a beacon of architectural excellence and a symbol of the timeless allure of traditional Rajasthani architecture.

The whole building is of uneven ceilings with wind canopy great parapet walls, sire an irregular sky & earth line overshadow in the concoct. At the forward lay they keep a include of Eaves like sunshades & balconies. At the base levels, the flush unit of the building

exterior are acutely carved devise finned flare up. Spotty building plan also clart irradiated heat loss from walls. Along raised wall area of the bumpy building mass scatter a better extent of heat to the sky as consequence stays cooler than a more covenant mass.



Ground floor plan

First floor plan



Fig.4.3 Map of Haveli

4.1.3 Doors and Walls

The doors were uniquely crafted with two faces, split into separate halves. Fashioned from sturdy local wood, these doors featured intricate metal embellishments, adding to their decorative appeal while retaining their functionality.



Fig. 4.4 door of Haveli

- Walls are made of local stone, mud mortar and finished with mud plaster constructed by local people of village. At upper floor level where the building facade projects out, 50mm thick panels of limestone are used as wall element.
- High walls, with pierced screens (jalis), for air and limited views, helped maintain privacy.
- The careful use of bamboo blinds (chiks) and curtains (pardas).
- Stone built into the walls, provided anchorage for the awnings which were stretched across courts and terraces, and wooden platforms covered in nutting were used to extend the floor areas.



Fig. 4.5 wall of Haveli

4.1.4 Windows and Jallis:

Windows & balconies are typically proper fit with jallis or lattice windows. Curtain like windows for secrecy as well to reduce dust but at the alike time allow in wind to interior.

Doors are made with stone flounce and suited with timber doors.

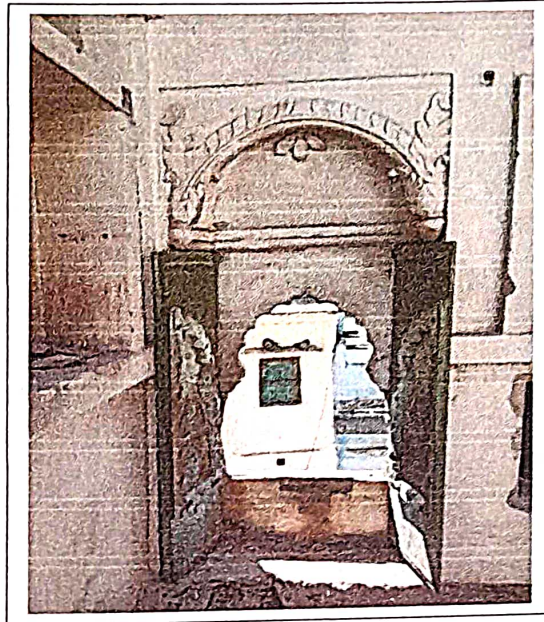
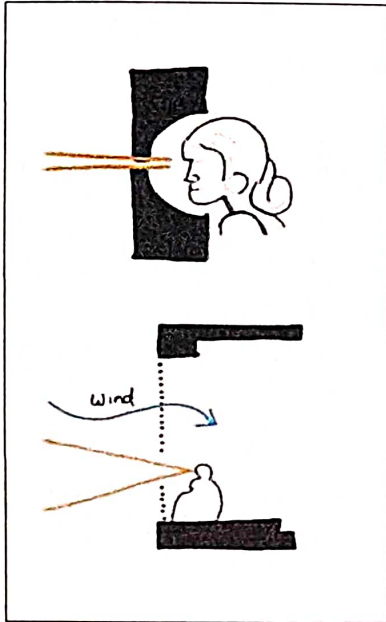


Fig.4.6 Widows of the Haveli



Fig.4.7 Jallis of the Haveli

4.1.5 Roof of The Haveli:

At this haveli the roof is mainly made by wood, and it looks like this from below –

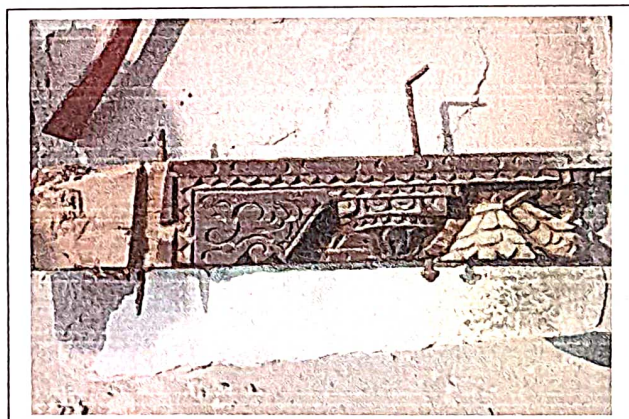
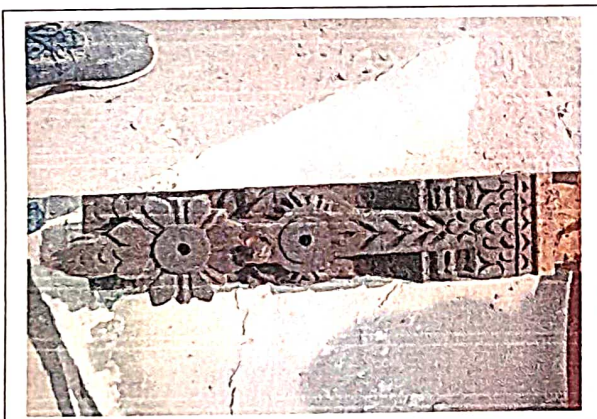
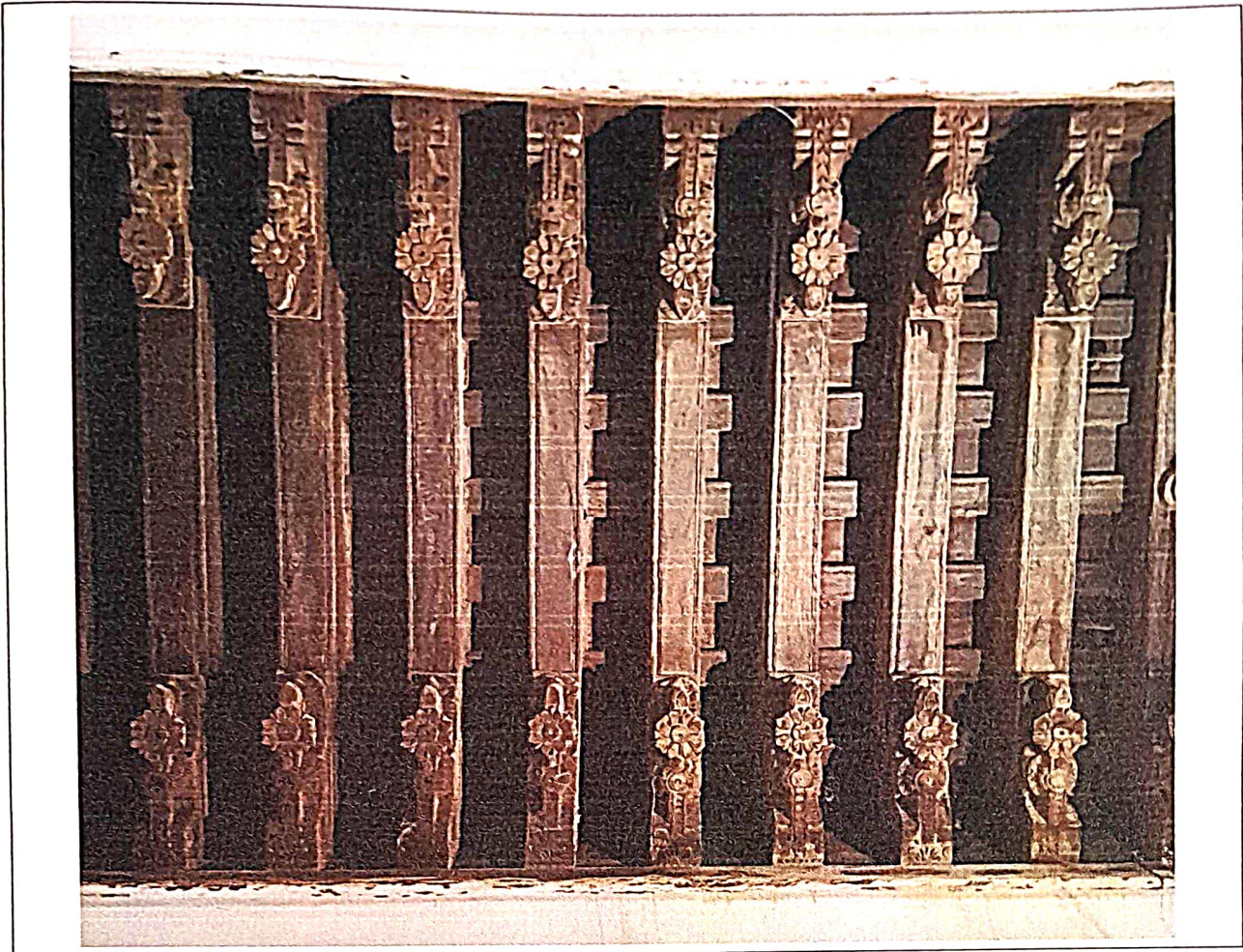


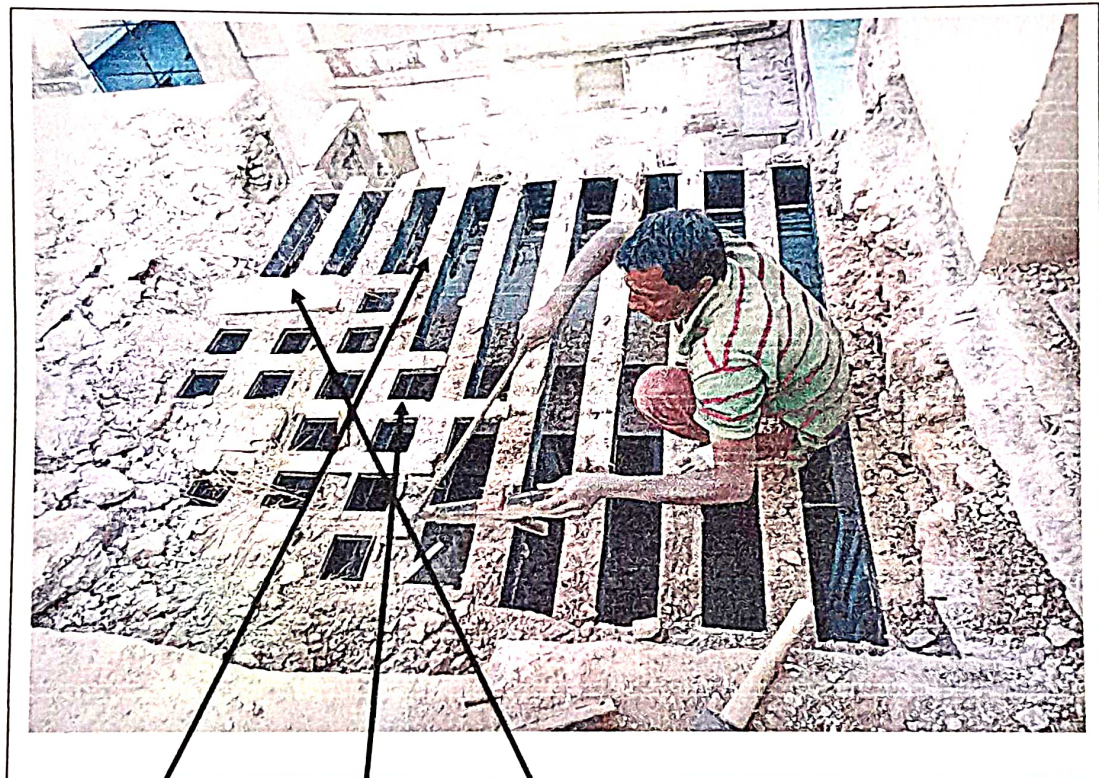
Fig.4.8. Roof of Haveli

4.1.5.1 Construction of roof:

A detailed process of constructing the roof of a traditional Haveli in Rajasthan, following the steps you provided:

1. Preparation of Base Structure:

- Firstly, thick wooden timbers are horizontally laid across the walls of the Haveli. These timbers serve as the base for the roof and are often handcrafted for decorative purposes, showcasing intricate designs and patterns.



Thick Timber

Patkhadi

Patiya (less Thick and Broad timber)

Fig.4.9. Construction of Roof of Haveli

2. Installation of Patkhadi:

- Vertically, broader but less thick wooden timbers, known as patkhadi, are laid above the base structure. These patkhadi provide additional support and stability to the roof framework.

3. Formation of Roof Structure:

- The combination of horizontally laid thick timbers and vertically placed patkhadi creates an empty or vacant square shape, forming the framework for the roof.

4. Filling the Roof Frame:

- Within this empty square structure, ununiform large wooden timbers are placed horizontally to fill the space. These timbers vary in size and are arranged in a haphazard manner to create a sturdy foundation for the roof.

5. Adding Insulation Layer:

- On top of the wooden framework, a layer of grass, typically around 3-4 inches thick, is spread evenly across the surface. This grass layer serves as insulation, helping to regulate the temperature inside the Haveli and providing protection against heat and cold.

6. Application of Clay and Stone Mixture:

- Following the grass layer, a mixture of dry clay and stones is spread over the roof, filling the space to a height of around 2-3 feet. This mixture acts as a further insulating layer, adding strength and stability to the roof structure.

The Course of earth & grass covering control the inside refreshing air conditioned.

7. Finishing Touches:

- Finally, the surface of the roof is given a finishing touch by applying a layer of limestone. This limestone coating not only enhances the aesthetic appeal of the roof but also provides protection against weathering and erosion, ensuring the longevity of the Haveli's roof.

In essence, the construction of the roof of a traditional Haveli involves a meticulous process that combines indigenous building techniques with natural materials, resulting in a structure that is not only aesthetically pleasing but also durable and functional, reflecting the rich architectural heritage of the region.

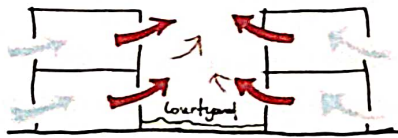
5. CHAPTER 5

5.1 CONCLUSIONS

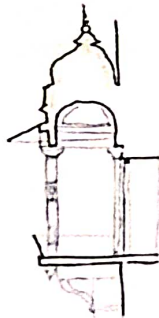
After studying the Havelis in detail, following conclusion can be made by our self as:

- The Havelis react best aptly to the weather of region and culture of the community in rate of material excerpt, spatial alignment, construction style and benefit of passive design feature.
- With the mixed result of all features, the interior of the building ever brings a cozy habitat when the surroundings appearance was annoying.
- The identical space could not equip the covet refresh in all seasons. Thus, there were an array of spaces (open, semi open, and enclosed), which were worn, in various period and times of day.
- The inclusion of static study mien uses an inclusive path to form precise from the rise of building. This intend that the construction method to be endorse, the plan at cluster level and building level, the materials to be used and all other point required to be route together to clear up the issue in an eco-friendly, philosophically, climatically and cost-effective & efficient manner.

5.1.1 Indigenous Design Solution in Modern Buildings.



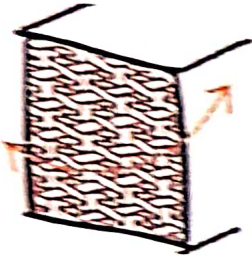
1) Insertion of courtyard – for achieving stack effect



2) Providing jharokhas – nowadas as a overhanging balcony which gives shade as well as aesthetical element



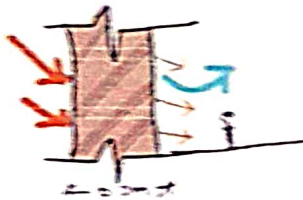
- 3) Providing chujus- nowadays as extending the eaves
 - shade purpose
 Large projection provide shade to facade



- 4) Providing jalis- nowadays for ventilation without dust
 and as well as facade treatment
 Deep curved patterns - minimize the heat gain



- 5) Uneven building forms- radiative heat loss from walls.



- 6) Increased wall surface - greater amount of heat loss as
 a result cooling effect

Thus the time and money spend in modern buildings to achieve energy efficiency can be achieved by endorsing our vernacular architecture which has many hidden profits in it. Vernacular architecture beauty lies in responding to the context. Giving truth to the existing one without altering the truth. Entire process has been borne in our contemporary buildings it emerges as a "PARADISE".

CHAPTER 6

6.1 LITERATURE REVIEW

6.1.1 Article 1

INDIGENOUS ARCHITECTURE AND NATURAL COOLING

Vinod Gupta, assistant professor of architecture school of planning & architecture, New Delhi

'Jharokha' literally means 'a small window'. It is a term which when one hears, is forced to think of some famous Bollywood songs of the 1960's, the heroine waiting for the protagonist leaning against the 'jharokha' in a moonlit night and also the hero trying to meet the heroine at the jharokha after facing all odds and so on, the imagination does not cease. Jharokha has come a long way from being a mere source of light and ventilation to be conceived as a divine concept. It has been seen in numerous paintings of Indian art primarily that of the Mughals, during the period of Akbar, Jahangir, Shah Jahan. The same stands for the Indian Architecture where the jharokha has been represented irrespective of any religion, whether in the form of a 'false window' as a mere decorative element or a part of the daily routine or 'ritual' where the king would appear to assure of his good health and well-being to his subjects. The Indian Architecture has witnessed some of the simplest jharokhas to the most ornately carved ones. Similarly, it is also an important element of theatre of the past and the present as well. Here, in research paper, I aim to trace a brief history of the relevance of jharokha in Indian Art and Architecture and its role and use in folk theatre focusing essentially on its changing faces with the changing time.

6.1.2 Article 2

COOLING THROUGH NATURAL VENTILATION (DOORS & WINDOWS)

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Natural ventilation relies on the wind and the "chimney effect" to keep a home cool. The wind will naturally ventilate your home by entering or leaving windows, depending on their orientation to the wind. When wind blows against your home, air is forced into your home. Heat accumulates in your home during the day, and the cool night air can flush it out. Depending on the house design and wind direction, a windbreak—like a fence, hedge, or row of trees that blocks the wind can force air either into or away from nearby windows. Wind moving along a wall creates a vacuum that pulls air out of the windows. The chimney effect occurs

when cool air enters a home on the first floor or basement, absorbs heat in the room, rises, and exits through upstairs windows. This creates a partial vacuum, which pulls more air in through lower-level windows. Natural ventilation works best in climates with cool summers or cool nights and regular breezes. Using Windows and Doors for Cross-Ventilation You can create natural cross-ventilation by adjusting the size and location of the openings to ventilate different parts of the home. Inlets and outlets located directly opposite each other cool only those areas in between, in the direct path of the airflow. Increases air speed and improves the cooling effect. Air from cooler, shaded outdoor areas provides the best intake air.

6.1.3 Article 3

BUILDINGS AND THERMAL COMFORT

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A new consciousness evident in modern architecture is the need to design buildings so that they stay cool in the summer and warm in the winter without consuming a great deal of energy in the process. 'Passive solar architecture', as It Is called, is the architect's response to the global energy crisis. The availability of cheap fossil fuels in the decades past was responsible for distorting people's expectations from buildings. Glass, concrete and steel boxes were built by the thousands and each of these had to have air conditioning plants to control the internal temperature within the narrow range defined as "comfortable". While It Is likely that the working efficiency in such buildings is high, it is equally likely that continuous exposure to the controlled environment makes people lose, at least partially, their natural ability to adapt to different thermal conditions. A much better situation is one in which buildings are designed to ameliorate the worst of the weather, and man can then Interact positively with the environment to find comfortable working and living conditions. In the cities of northern India this has been achieved by appropriate organization of social and economic activities, in addition to good town planning and building design. Even though there is a superficial similarity between the northern Indian cities of Jaisalmer and Delhi have been built and function differently. It is Interesting to see how the builders of these cities overcame the problems of building in the harsh climate.

6.2 REFERENCES

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